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4TH YEAR

MACHINE LEARNING ASSIGNMENT 1

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import seaborn as sns
%matplotlib inline
sns.set()
```

LOADING IRIS DATASET

```
iris = sns.load_dataset("iris")
iris.head()
```

	sepal_length	sepal_width	petal_length	petal_width	species
0	5.1	3.5	1.4	0.2	setosa
1	4.9	3.0	1.4	0.2	setosa
2	4.7	3.2	1.3	0.2	setosa
3	4.6	3.1	1.5	0.2	setosa
4	5.0	3.6	1.4	0.2	setosa

```
iris['species'].unique()
```

```
array(['setosa', 'versicolor', 'virginica'], dtype=object)
```

```
iris.describe(include='all')
```

	sepal_length	sepal_width	petal_length	petal_width	species
count	150.000000	150.000000	150.000000	150.000000	150
unique	NaN	NaN	NaN	NaN	3
top	NaN	NaN	NaN	NaN	virginica
freq	NaN	NaN	NaN	NaN	50

```
iris.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 5 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   sepal_length  150 non-null    float64
 1   sepal_width   150 non-null    float64
 2   petal_length  150 non-null    float64
 3   petal_width   150 non-null    float64
 4   species       150 non-null    object 
dtypes: float64(4), object(1)
memory usage: 6.0+ KB
```

```
iris.isnull().sum()
```

```
sepal_length    0
sepal_width     0
petal_length    0
petal_width     0
species         0
dtype: int64
```

```
REFACTORING DATASET INTO X AND Y MATRICES
```

```
X=iris.iloc[:,0:4].values
y=iris.iloc[:,4].values
```

TRANSFORMING LABELS TO NUMERIC CLASSES

```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
y = le.fit_transform(y)
```

```
#Metrics
from sklearn.metrics import make_scorer, accuracy_score,precision_score
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score ,precision_score,recall_score,f1_score
from sklearn.model_selection import GridSearchCV
#Model Select
from sklearn.model_selection import KFold,train_test_split,cross_val_score
from sklearn.model_selection import train_test_split
```

```
from sklearn.naive_bayes import GaussianNB,BernoulliNB,MultinomialNB
```

SPLITTING DATASET INTO TRAIN AND TEST

```
X_train,X_test,y_train,y_test=train_test_split(X,y,test_size=0.3,random_state=0)
```

GAUSSIAN NAIVE BAYES CLASSIFIER

```
gaussian = GaussianNB()
gaussian.fit(X_train, y_train)
Y_pred = gaussian.predict(X_test)
```

```
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[16  0  0]
 [ 0 18  0]
 [ 0  0 11]]
accuracy_Naive Bayes: 1.000
precision_Naive Bayes: 1.000
recall_Naive Bayes: 1.000
f1-score_Naive Bayes : 1.000
```

GAUSSIAN NAIVE BAYES CLASSIFIER WITH PARAMETER TUNING

```
params = {'var_smoothing': np.logspace(0,-9, num=100)}
gaussian_nb_grid = GridSearchCV(GaussianNB(), param_grid=params, n_jobs=-1, cv=5, verbose=
gaussian_nb_grid.fit(X_train, y_train)
Y_pred = gaussian_nb_grid.predict(X_test)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  14 tasks      | elapsed:    0.8s
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:    1.4s finished
```

```
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
```

```
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[16  0  0]
 [ 0 17  1]
 [ 0  2  9]]
accuracy_Naive Bayes: 0.933
precision_Naive Bayes: 0.933
recall_Naive Bayes: 0.933
f1-score_Naive Bayes : 0.933
```

MULTINOMIAL NAIVE BAYES CLASSIFIER

```
multinomial = MultinomialNB()
multinomial.fit(X_train, y_train)
Y_pred = multinomial.predict(X_test)
```

```
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[16  0  0]
 [ 0  0 18]
 [ 0  0 11]]
accuracy_Naive Bayes: 0.600
precision_Naive Bayes: 0.600
recall_Naive Bayes: 0.600
f1-score_Naive Bayes : 0.600
```

MULTINOMIAL NAIVE BAYES CLASSIFIER WITH PARAMETER TUNING

```
params = {'alpha': [0.01, 0.05, 0.1, 0.5, 1.0, 10.0, ],
         }

multinomial_nb_grid = GridSearchCV(MultinomialNB(), param_grid=params, n_jobs=-1, cv=5, ve
multinomial_nb_grid.fit(X_train, y_train)
Y_pred = multinomial_nb_grid.predict(X_test)
```

```
Fitting 5 folds for each of 6 candidates, totalling 30 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
```

```
[Parallel(n_jobs=-1)]: Done  20 out of  30 | elapsed:    0.1s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done  30 out of  30 | elapsed:    0.1s finished
```

```
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[16  0  0]
 [ 0  0 18]
 [ 0  0 11]]
accuracy_Naive Bayes: 0.600
precision_Naive Bayes: 0.600
recall_Naive Bayes: 0.600
f1-score_Naive Bayes : 0.600
```

BERNOULLI NAIVE BAYES CLASSIFIER

```
bernoulli = BernoulliNB()
bernoulli.fit(X_train, y_train)
Y_pred = bernoulli.predict(X_test)


accuracy_nb=round(accuracy_score(y_test,Y_pred)* 100, 2)
acc_gaussian = round(bernoulli.score(X_train, y_train) * 100, 2)

cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[ 0  0 16]
 [ 0  0 18]
 [ 0  0 11]]
accuracy_Naive Bayes: 0.244
precision_Naive Bayes: 0.244
recall_Naive Bayes: 0.244
f1-score_Naive Bayes : 0.244
```

BERNOULLI NAIVE BAYES CLASSIFIER WITH PARAMETER TUNING

```
params = {'alpha': [0.01, 0.05, 0.1, 0.5, 1.0, 10.0],
         }

bernoulli_nb_grid = GridSearchCV(BernoulliNB(), param_grid=params, n_jobs=-1, cv=5, verbos
bernoulli_nb_grid.fit(X_train, y_train)
Y_pred = bernoulli_nb_grid.predict(X_test)
```

```
Fitting 5 folds for each of 6 candidates, totalling 30 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  30 out of  30 | elapsed:    0.1s finished
```

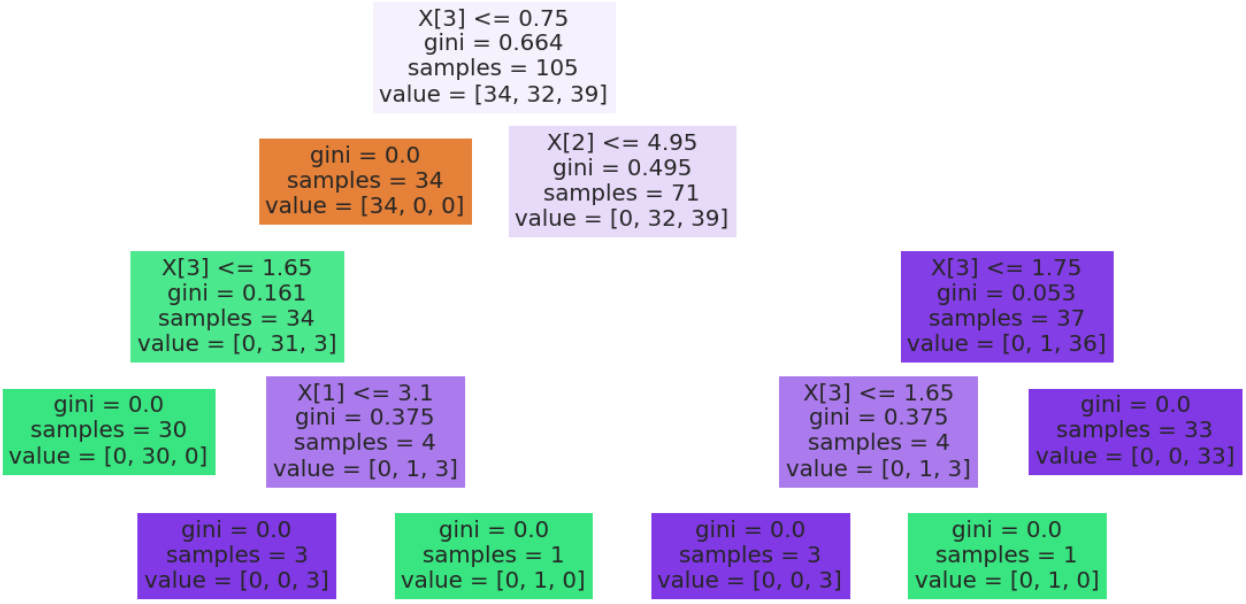
```
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[ 0  0 16]
 [ 0  0 18]
 [ 0  0 11]]
accuracy_Naive Bayes: 0.244
precision_Naive Bayes: 0.244
recall_Naive Bayes: 0.244
f1-score_Naive Bayes : 0.244
```

```
from sklearn.tree import DecisionTreeClassifier, plot_tree
```

GINI DECISION TREE

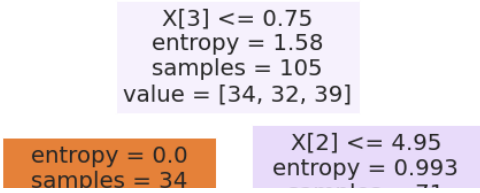
```
iris_gini_cf = DecisionTreeClassifier().fit(X_train, y_train)
plt.figure(figsize = (20,10))
plot_tree(iris_gini_cf,
          filled=True)
plt.show()
```




```
y_pred_gini = iris_gini_cf.predict(X_test)
```

ENTROPY DECISION TREE

```
iris_entropy_cf = DecisionTreeClassifier(criterion='entropy').fit(X_train, y_train)
plt.figure(figsize = (20,10))
plot_tree(iris_entropy_cf,
          filled=True)
plt.show()
```




```
y_pred_entropy = iris_entropy_cf.predict(X_test)
```

```
target_names = ["Iris-setosa", "Iris-versicolor", "Iris-virginica"]
print("------------ Iris Dataset DecisionTree -------------")
print("Gini:")
print(confusion_matrix(y_test, y_pred_gini))
print(classification_report(y_test, y_pred_gini, target_names=target_names))
print("Entropy:")
print(confusion_matrix(y_test, y_pred_entropy))
print(classification_report(y_test, y_pred_entropy, target_names=target_names))
```

```
------------ Iris Dataset DecisionTree -------------
Gini:
[[16  0  0]
 [ 0 17  1]
 [ 0  0 11]]
                 precision    recall  f1-score   support

    Iris-setosa       1.00      1.00      1.00        16
Iris-versicolor       1.00      0.94      0.97        18
 Iris-virginica       0.92      1.00      0.96        11

       accuracy                           0.98        45
      macro avg       0.97      0.98      0.98        45
   weighted avg       0.98      0.98      0.98        45

Entropy:
[[16  0  0]
 [ 0 17  1]
 [ 0  0 11]]
                 precision    recall  f1-score   support

    Iris-setosa       1.00      1.00      1.00        16
Iris-versicolor       1.00      0.94      0.97        18
 Iris-virginica       0.92      1.00      0.96        11

       accuracy                           0.98        45
      macro avg       0.97      0.98      0.98        45
   weighted avg       0.98      0.98      0.98        45
```

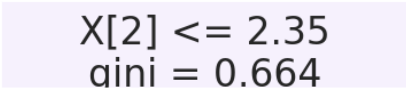
DECISION TREE WITH PARAMETER TUNING

```
param_grid_desci = {
    'max_depth': [2, 3, 5, 10, 20],
    'min_samples_leaf': [5, 10, 20, 50, 100],
    'criterion': ["gini", "entropy"]
}
```

```
classifier_desci_p = DecisionTreeClassifier()
clf = GridSearchCV(classifier_desci_p, param_grid_desci)
clf.fit(X_train, y_train)
```

```
GridSearchCV(cv=None, error_score=nan,
             estimator=DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None,
                                              criterion='gini', max_depth=None,
                                              max_features=None,
                                              max_leaf_nodes=None,
                                              min_impurity_decrease=0.0,
                                              min_impurity_split=None,
                                              min_samples_leaf=1,
                                              min_samples_split=2,
                                              min_weight_fraction_leaf=0.0,
                                              presort='deprecated',
                                              random_state=None,
                                              splitter='best'),
             iid='deprecated', n_jobs=None,
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': [2, 3, 5, 10, 20],
                         'min_samples_leaf': [5, 10, 20, 50, 100]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

```
plt.figure(figsize = (20,10))
plot_tree(clf.best_estimator_,
          filled=True)
plt.show()
```




```
y_pred = clf.predict(X_test)
```

```
print("------------ Iris Dataset DecisionTree Parameter-------------")
print(confusion_matrix(y_test, y_pred))
print(classification_report(y_test, y_pred, target_names=target_names))
```

```
------------ Iris Dataset DecisionTree Parameter-------------
[[16  0  0]
 [ 0 17  1]
 [ 0  3  8]]
                 precision    recall  f1-score   support

    Iris-setosa       1.00      1.00      1.00        16
Iris-versicolor       0.85      0.94      0.89        18
 Iris-virginica       0.89      0.73      0.80        11

       accuracy                           0.91        45
      macro avg       0.91      0.89      0.90        45
   weighted avg       0.91      0.91      0.91        45
```

LOADING DIABETES DATASET

```
from sklearn.datasets import load_diabetes
```

```
X,y=load_diabetes(return_X_y=True)
```

```
df1 = pd.DataFrame(X, columns=["age", "sex", "bmi", "bp", "s1", "s2", "s3", "s4", "s5", "s
df2 = pd.DataFrame(y, columns=["Y"])
```

```
diabetes = pd.merge(df1, df2, left_index=True, right_index=True)
print(diabetes.head())
```

```
        age       sex       bmi        bp  ...        s4        s5        s6      Y
0  0.038076  0.050680  0.061696  0.021872  ... -0.002592  0.019908 -0.017646  151.0
1 -0.001882 -0.044642 -0.051474 -0.026328  ... -0.039493 -0.068330 -0.092204   75.0
2  0.085299  0.050680  0.044451 -0.005671  ... -0.002592  0.002864 -0.025930  141.0
3 -0.089063 -0.044642 -0.011595 -0.036656  ...  0.034309  0.022692 -0.009362  206.0
4  0.005383 -0.044642 -0.036385  0.021872  ... -0.002592 -0.031991 -0.046641  135.0

[5 rows x 11 columns]
```

```
diabetes['sex'].unique()
```

```
array([ 0.05068012, -0.04464164])
```

```
diabetes.describe(include='all')
```

	age	sex	bmi	bp	s1	
count	4.420000e+02	4.420000e+02	4.420000e+02	4.420000e+02	4.420000e+02	4.420000e·
mean	-3.634285e-16	1.308343e-16	-8.045349e-16	1.281655e-16	-8.835316e-17	1.327024e
std	4.761905e-02	4.761905e-02	4.761905e-02	4.761905e-02	4.761905e-02	4.761905e
min	-1.072256e-01	-4.464164e-02	-9.027530e-02	-1.123996e-01	-1.267807e-01	-1.15613
25%	-3.729927e-02	-4.464164e-02	-3.422907e-02	-3.665645e-02	-3.424784e-02	-3.03584
50%	5.383060e-03	-4.464164e-02	-7.283766e-03	-5.670611e-03	-4.320866e-03	-3.81906

```
diabetes.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 442 entries, 0 to 441
Data columns (total 11 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   age     442 non-null    float64
 1   sex     442 non-null    float64
 2   bmi     442 non-null    float64
 3   bp      442 non-null    float64
 4   s1      442 non-null    float64
 5   s2      442 non-null    float64
 6   s3      442 non-null    float64
 7   s4      442 non-null    float64
 8   s5      442 non-null    float64
 9   s6      442 non-null    float64
 10  Y       442 non-null    float64
dtypes: float64(11)
memory usage: 38.1 KB
```

USING 'SEX' COLUMN AS CLASSIFICATION COLUMN

```
y=diabetes.iloc[:,1].values
X=diabetes.drop('sex', axis=1)
print(X.shape, y.shape)
```

```
(442, 10) (442,)
```

```
X.head()
```

	age	bmi	bp	s1	s2	s3	s4	s5
0	0.038076	0.061696	0.021872	0.044223	0.034821	0.043401	0.002592	0.019908

```
y = le.fit_transform(y)
```

SPLITTING DATASET INTO TRAIN AND TEST

```
X_train,X_test,y_train,y_test=train_test_split(X,y,test_size=0.3,random_state=0)
```

GAUSSIAN NAIVE BAYES

```
gaussian.fit(X_train, y_train)
Y_pred = gaussian.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[48 26]
 [17 42]]
accuracy_Naive Bayes: 0.677
precision_Naive Bayes: 0.677
recall_Naive Bayes: 0.677
f1-score_Naive Bayes : 0.677
```

GAUSSIAN NAIVE BAYES WITH PARAMETER TUNING

```
gaussian_nb_grid.fit(X_train, y_train)
Y_pred = gaussian_nb_grid.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  14 tasks      | elapsed:    1.2s
Confusion matrix for Naive Bayes
```

```
 [[51 23]
 [18 41]]
accuracy_Naive Bayes: 0.692
precision_Naive Bayes: 0.692
recall_Naive Bayes: 0.692
f1-score_Naive Bayes : 0.692
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:    2.4s finished
```

BERNOULLI NAIVE BAYES

```
bernoulli.fit(X_train, y_train)
Y_pred = bernoulli.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[51 23]
 [14 45]]
accuracy_Naive Bayes: 0.722
precision_Naive Bayes: 0.722
recall_Naive Bayes: 0.722
f1-score_Naive Bayes : 0.722
```

BERNOULLI NAIVE BAYES WITH PARAMETER TUNING

```
bernoulli_nb_grid.fit(X_train, y_train)
Y_pred = bernoulli_nb_grid.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Fitting 5 folds for each of 6 candidates, totalling 30 fits
Confusion matrix for Naive Bayes
 [[51 23]
 [14 45]]
accuracy_Naive Bayes: 0.722
precision_Naive Bayes: 0.722
recall_Naive Bayes: 0.722
f1-score_Naive Bayes : 0.722
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  30 out of  30 | elapsed:    0.1s finished
```

SCALING REQUIRED FOR MULTINOMIAL NAIVE BAYES AS NEGATIVE VALUES CANNOT BE SUPPLIED.

```
from sklearn.preprocessing import MinMaxScaler

scaler = MinMaxScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.fit_transform(X_test)
```

MULTINOMIAL NAIVE BAYES

```
multinomial.fit(X_train, y_train)
Y_pred = multinomial.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[59 15]
 [23 36]]
accuracy_Naive Bayes: 0.714
precision_Naive Bayes: 0.714
recall_Naive Bayes: 0.714
f1-score_Naive Bayes : 0.714
```

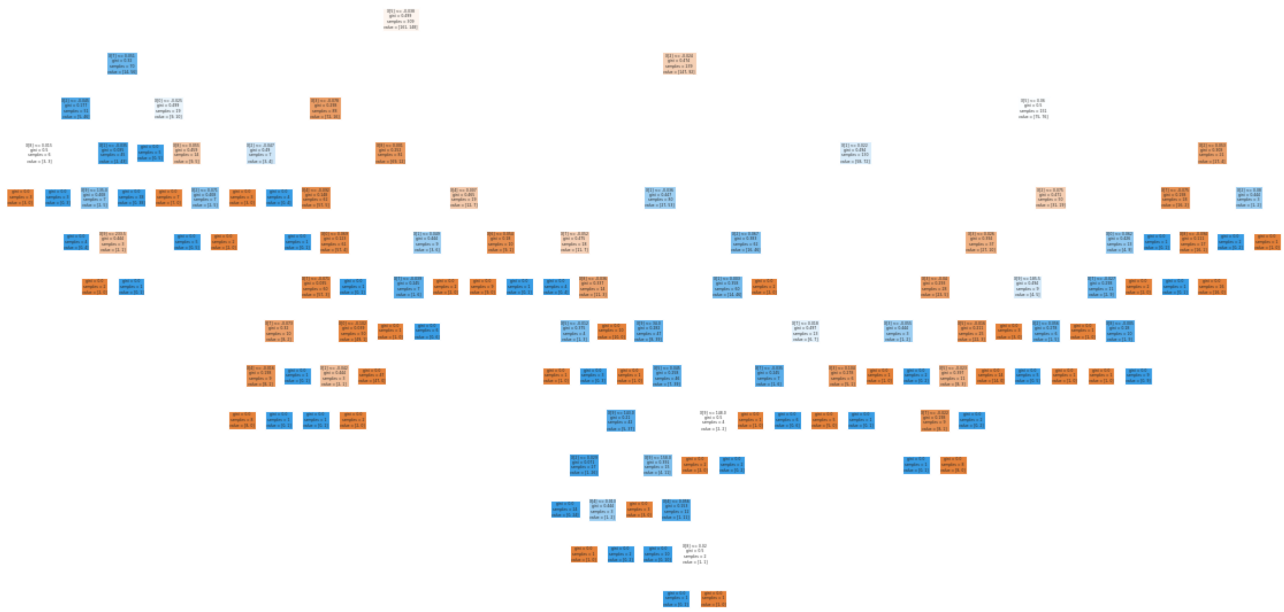
MULTINOMIAL NAIVE BAYES WITH PARAMETER TUNING

```
multinomial_nb_grid.fit(X_train, y_train)
Y_pred = multinomial_nb_grid.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Fitting 5 folds for each of 6 candidates, totalling 30 fits
Confusion matrix for Naive Bayes
 [[59 15]
 [23 36]]
accuracy_Naive Bayes: 0.714
precision_Naive Bayes: 0.714
recall_Naive Bayes: 0.714
f1-score_Naive Bayes : 0.714
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  24 tasks      | elapsed:    0.1s
[Parallel(n_jobs=-1)]: Done  27 out of  30 | elapsed:    0.1s remaining:    0.0s
[Parallel(n_jobs=-1)]: Done  30 out of  30 | elapsed:    0.1s finished
```

GINI DECISION TREE

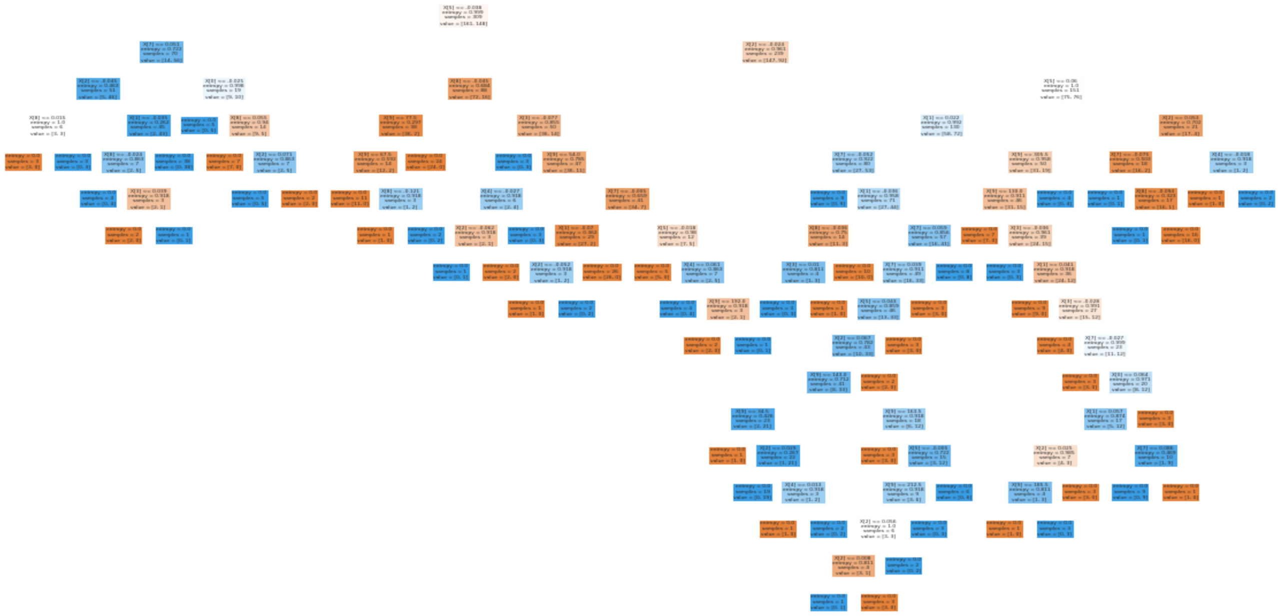
```
diab_gini_cf = DecisionTreeClassifier().fit(X_train, y_train)
plt.figure(figsize = (20,10))
plot_tree(diab_gini_cf,
          filled=True)
plt.show()
```



```
y_pred_gini = diab_gini_cf.predict(X_test)
```

ENTROPY DECISION TREE

```
diab_entropy_cf = DecisionTreeClassifier(criterion='entropy').fit(X_train, y_train)
plt.figure(figsize = (20,10))
plot_tree(diab_entropy_cf,
          filled=True)
plt.show()
```



```
y_pred_entropy = diab_entropy_cf.predict(X_test)
```

```
target_names = ["0", "1"]
print("------------ Diabetes Dataset DecisionTree -------------")
print("Gini:")
print(confusion_matrix(y_test, y_pred_gini))
print(classification_report(y_test, y_pred_gini, target_names=target_names))
print("Entropy:")
print(confusion_matrix(y_test, y_pred_entropy))
print(classification_report(y_test, y_pred_entropy, target_names=target_names))
```

```
------------ Diabetes Dataset DecisionTree -------------
Gini:
```

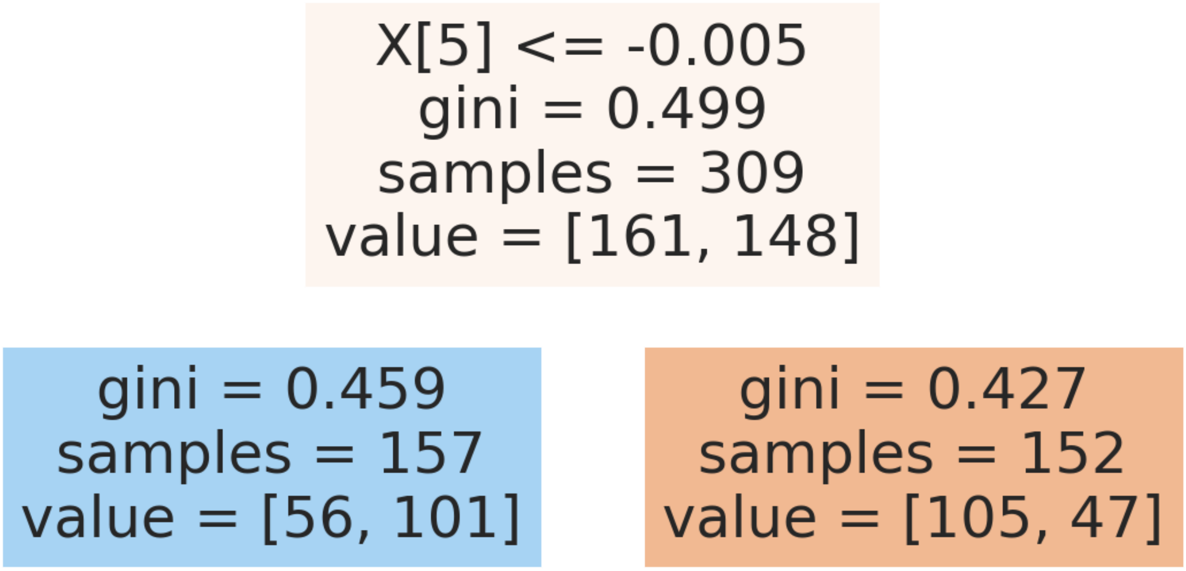
```
[[44 30]
 [21 38]]
              precision    recall  f1-score   support

           0       0.68      0.59      0.63        74
           1       0.56      0.64      0.60        59

    accuracy                           0.62       133
   macro avg       0.62      0.62      0.62       133
weighted avg       0.62      0.62      0.62       133

Entropy:
[[41 33]
 [18 41]]
              precision    recall  f1-score   support

           0       0.69      0.55      0.62        74
           1       0.55      0.69      0.62        59

    accuracy                           0.62       133
   macro avg       0.62      0.62      0.62       133
weighted avg       0.63      0.62      0.62       133
```

DECISION TREE WITH PARAMETER TUNING

```
classifier_desci_p = DecisionTreeClassifier()
clf = GridSearchCV(classifier_desci_p, param_grid_desci)
clf.fit(X_train, y_train)
```

```
GridSearchCV(cv=None, error_score=nan,
             estimator=DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None,
                                              criterion='gini', max_depth=None,
                                              max_features=None,
                                              max_leaf_nodes=None,
                                              min_impurity_decrease=0.0,
                                              min_impurity_split=None,
                                              min_samples_leaf=1,
                                              min_samples_split=2,
                                              min_weight_fraction_leaf=0.0,
                                              presort='deprecated',
                                              random_state=None,
                                              splitter='best'),
             iid='deprecated', n_jobs=None,
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': [2, 3, 5, 10, 20],
                         'min_samples_leaf': [5, 10, 20, 50, 100]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

```
plt.figure(figsize = (20,10))
plot_tree(clf.best_estimator_,
          filled=True)
plt.show()
```




```
y_pred = clf.predict(X_test)
```

```
print("------------ Diabetes Dataset DecisionTree Parameter-------------")
print(confusion_matrix(y_test, y_pred))
print(classification_report(y_test, y_pred, target_names=target_names))
```

```
------------ Diabetes Dataset DecisionTree Parameter-------------
[[47 27]
 [15 44]]
              precision    recall  f1-score   support

           0       0.76      0.64      0.69        74
           1       0.62      0.75      0.68        59

    accuracy                           0.68       133
   macro avg       0.69      0.69      0.68       133
weighted avg       0.70      0.68      0.68       133
```

LOADING BREAST CANCER DATASET

```
from sklearn.datasets import load_breast_cancer
```

```
X,y=load_breast_cancer(return_X_y=True)
```

```
X.shape
```

```
(569, 30)
```

```
cancer = pd.DataFrame(X)
cancer.describe(include='all')
```

	0	1	2	3	4	5	
count	569.000000	569.000000	569.000000	569.000000	569.000000	569.000000	569.000(
mean	14.127292	19.289649	91.969033	654.889104	0.096360	0.104341	0.088
std	3.524049	4.301036	24.298981	351.914129	0.014064	0.052813	0.079
min	6.981000	9.710000	43.790000	143.500000	0.052630	0.019380	0.000(
25%	11.700000	16.170000	75.170000	420.300000	0.086370	0.064920	0.029
50%	13.370000	18.840000	86.240000	551.100000	0.095870	0.092630	0.061
75%	15.780000	21.800000	104.100000	782.700000	0.105300	0.130400	0.130
max	28.110000	39.280000	188.500000	2501.000000	0.163400	0.345400	0.426

SPLITTING DATASET INTO TEST AND TRAIN

```
X_train,X_test,y_train,y_test=train_test_split(X,y,test_size=0.3,random_state=0)
```

GAUSSIAN NAIVE BAYES

```
gaussian.fit(X_train, y_train)
Y_pred = gaussian.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[ 57   6]
 [  7 101]]
accuracy_Naive Bayes: 0.924
precision_Naive Bayes: 0.924
recall_Naive Bayes: 0.924
f1-score_Naive Bayes : 0.924
```

GAUSSIAN NAIVE BAYES WITH PARAMETER TUNING

```
gaussian_nb_grid.fit(X_train, y_train)
Y_pred = gaussian_nb_grid.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Fitting 5 folds for each of 100 candidates, totalling 500 fits
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  14 tasks      | elapsed:    0.8s
Confusion matrix for Naive Bayes
 [[ 57   6]
 [  7 101]]
accuracy_Naive Bayes: 0.924
precision_Naive Bayes: 0.924
recall_Naive Bayes: 0.924
f1-score_Naive Bayes : 0.924
[Parallel(n_jobs=-1)]: Done 500 out of 500 | elapsed:    1.6s finished
```

BERNOULLI NAIVE BAYES

```
bernoulli.fit(X_train, y_train)
Y_pred = bernoulli.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[  0  63]
 [  0 108]]
accuracy_Naive Bayes: 0.632
precision_Naive Bayes: 0.632
recall_Naive Bayes: 0.632
f1-score_Naive Bayes : 0.632
```

BERNOULLI NAIVE BAYES WITH PARAMETER TUNING

```
bernoulli_nb_grid.fit(X_train, y_train)
Y_pred = bernoulli_nb_grid.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Fitting 5 folds for each of 6 candidates, totalling 30 fits
Confusion matrix for Naive Bayes
 [[  0  63]
 [  0 108]]
accuracy_Naive Bayes: 0.632
precision_Naive Bayes: 0.632
recall_Naive Bayes: 0.632
f1-score_Naive Bayes : 0.632
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  30 out of  30 | elapsed:    0.1s finished
```

MULTINOMIAL NAIVE BAYES

```
multinomial.fit(X_train, y_train)
Y_pred = multinomial.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Confusion matrix for Naive Bayes
 [[ 48  15]
 [  2 106]]
accuracy_Naive Bayes: 0.901
precision_Naive Bayes: 0.901
recall_Naive Bayes: 0.901
f1-score_Naive Bayes : 0.901
```

MULTINOMIAL NAIVE BAYES WITH PARAMETER TUNING

```
multinomial_nb_grid.fit(X_train, y_train)
Y_pred = multinomial_nb_grid.predict(X_test)
cm = confusion_matrix(y_test, Y_pred)
accuracy = accuracy_score(y_test,Y_pred)
precision =precision_score(y_test, Y_pred,average='micro')
```

```
recall =  recall_score(y_test, Y_pred,average='micro')
f1 = f1_score(y_test,Y_pred,average='micro')
print('Confusion matrix for Naive Bayes\n',cm)
print('accuracy_Naive Bayes: %.3f' %accuracy)
print('precision_Naive Bayes: %.3f' %precision)
print('recall_Naive Bayes: %.3f' %recall)
print('f1-score_Naive Bayes : %.3f' %f1)
```

```
Fitting 5 folds for each of 6 candidates, totalling 30 fits
Confusion matrix for Naive Bayes
 [[ 48  15]
 [  2 106]]
accuracy_Naive Bayes: 0.901
precision_Naive Bayes: 0.901
recall_Naive Bayes: 0.901
f1-score_Naive Bayes : 0.901
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done  30 out of  30 | elapsed:    0.1s finished
```

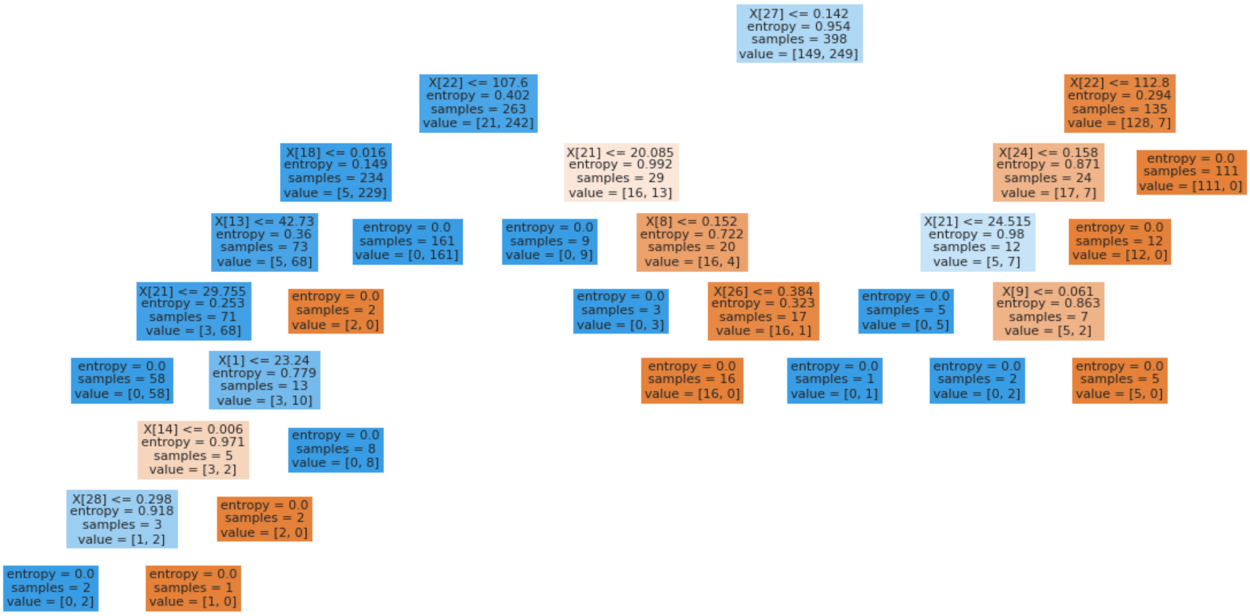
GINI DECISION TREE

```
bcw_gini_cf = DecisionTreeClassifier().fit(X_train, y_train)
plt.figure(figsize = (20,10))
plot_tree(bcw_gini_cf,
          filled=True)
plt.show()
```

```
y_pred_gini = bcw_gini_cf.predict(X_test)
```

ENTROPY DECISION TREE

```
bcw_entropy_cf = DecisionTreeClassifier(criterion='entropy').fit(X_train, y_train)
plt.figure(figsize = (20,10))
plot_tree(bcw_entropy_cf,
          filled=True)
plt.show()
```




```
y_pred_entropy = bcw_entropy_cf.predict(X_test)
```

```
print("------------ Breast Cancer Wisconsin Dataset DecisionTree -------------")
print("Gini:")
print(confusion_matrix(y_test, y_pred_gini))
print(classification_report(y_test, y_pred_gini, target_names=target_names))
print("Entropy:")
print(confusion_matrix(y_test, y_pred_entropy))
```

```
print(classification_report(y_test, y_pred_entropy, target_names=target_names))
```

```
------------ Breast Cancer Wisconsin Dataset DecisionTree -------------
Gini:
[[59  4]
 [11 97]]
              precision    recall  f1-score   support

           0       0.84      0.94      0.89        63
           1       0.96      0.90      0.93       108

    accuracy                           0.91       171
   macro avg       0.90      0.92      0.91       171
weighted avg       0.92      0.91      0.91       171

Entropy:
[[ 60   3]
 [  8 100]]
              precision    recall  f1-score   support

           0       0.88      0.95      0.92        63
           1       0.97      0.93      0.95       108

    accuracy                           0.94       171
   macro avg       0.93      0.94      0.93       171
weighted avg       0.94      0.94      0.94       171
```

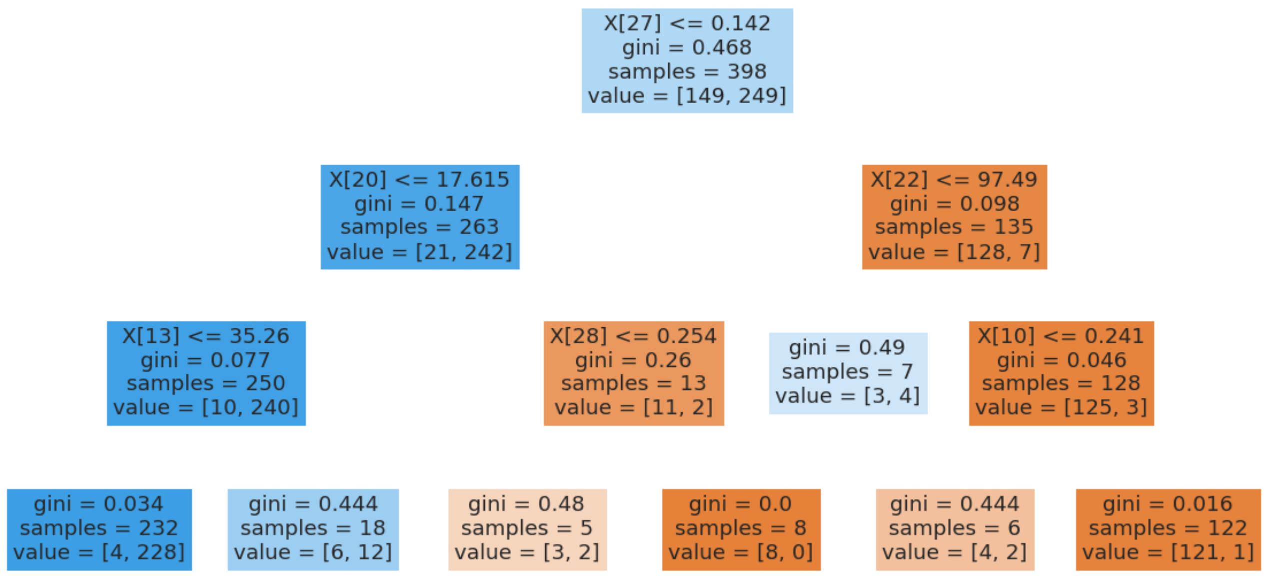
DECISION TREE WITH PARAMETER TUNING

```
classifier_desci_p = DecisionTreeClassifier()
clf = GridSearchCV(classifier_desci_p, param_grid_desci)
clf.fit(X_train, y_train)
```

```
GridSearchCV(cv=None, error_score=nan,
             estimator=DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None,
                                              criterion='gini', max_depth=None,
                                              max_features=None,
                                              max_leaf_nodes=None,
                                              min_impurity_decrease=0.0,
                                              min_impurity_split=None,
                                              min_samples_leaf=1,
                                              min_samples_split=2,
                                              min_weight_fraction_leaf=0.0,
                                              presort='deprecated',
                                              random_state=None,
                                              splitter='best'),
             iid='deprecated', n_jobs=None,
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': [2, 3, 5, 10, 20],
                         'min_samples_leaf': [5, 10, 20, 50, 100]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

```
plt.figure(figsize = (20,10))
plot_tree(clf.best_estimator_,
          filled=True)
plt.show()
```

```
plt.show()
```




```
y_pred = clf.predict(X_test)


print("------------ Breast Cancer Wisconsin Dataset DecisionTree Parameter-------------")
print(confusion_matrix(y_test, y_pred))
print(classification_report(y_test, y_pred, target_names=target_names))
```

```
------------ Breast Cancer Wisconsin Dataset DecisionTree Parameter-------------
[[ 59   4]
 [  5 103]]
              precision    recall  f1-score   support

           0       0.92      0.94      0.93        63
           1       0.96      0.95      0.96       108

    accuracy                           0.95       171
   macro avg       0.94      0.95      0.94       171
weighted avg       0.95      0.95      0.95       171
```

0s completed at 21:59